Lawrence Livermore National Laboratory

Double-Sided Interferometer for Profiling Measurements Simultaneously Determining Thickness and Form

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Michael J. Wilson

Lawrence Livermore National Laboratory, P. O. Box 808, Livermore, CA 94551

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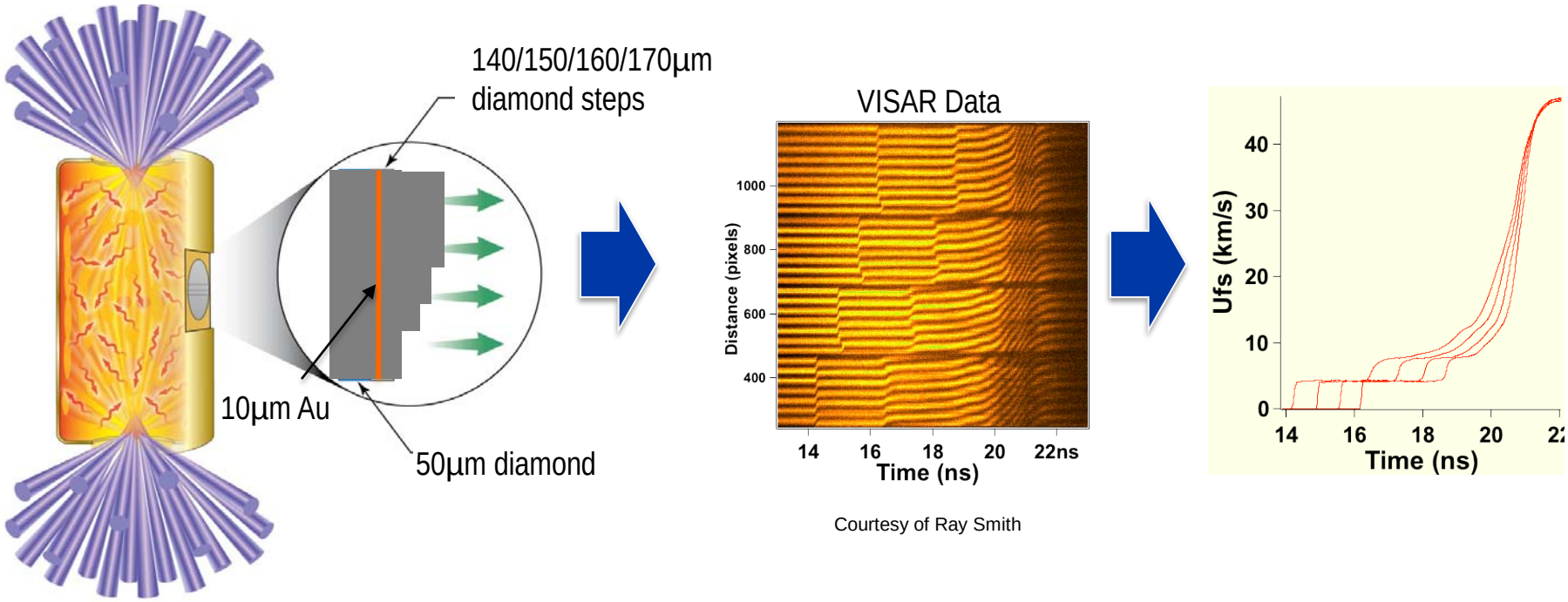
Overview

- Background
- Requirements
- Design Progression
  - Describe the design logic and the reason to change the design
- Results
- Summary

To be able to accurately analyze the experiment the absolute thickness must be known



Courtesy of Ray Smith

NIF-0310-18630

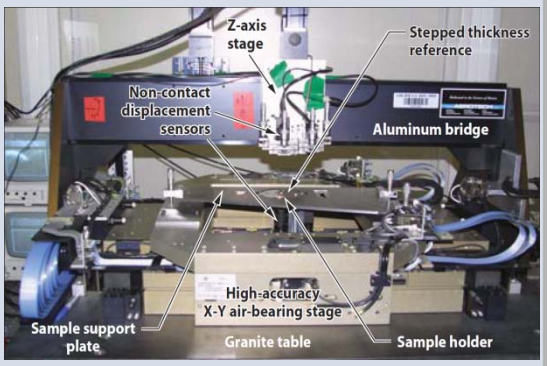
Requirements

- Absolute thickness measurements and form
- Thickness uncertainty of 250 nm
- Uses commercially supported metrology tools
- Uses standard metrology tool interface to collect data
- Ability to use both a laser profilometer and white light interferometer
- Measure both transparent and opaque samples
- Completes a measurement in an hour or less

Design Progression

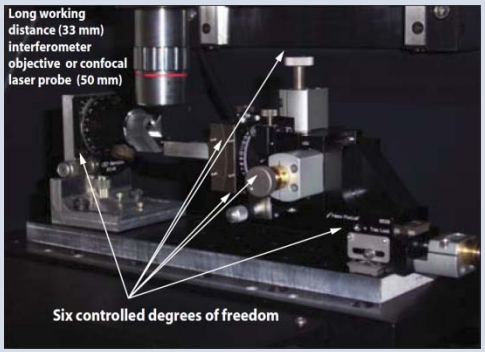
ATMM

- Confocal laser probe
- Able to measure thickness with an uncertainty of 510 nm



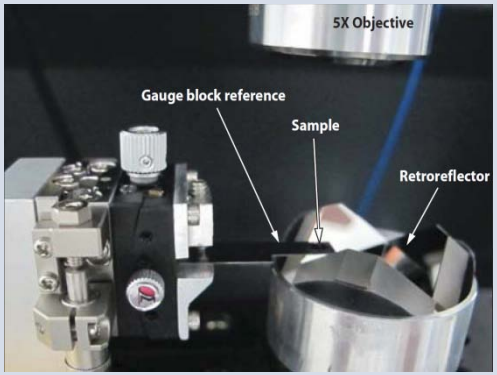
Double-Sided Prism Design

- White light interferometer or laser probe
- Able to measure thickness with an uncertainty of 1.2 µm



Double-Sided Corner Cube

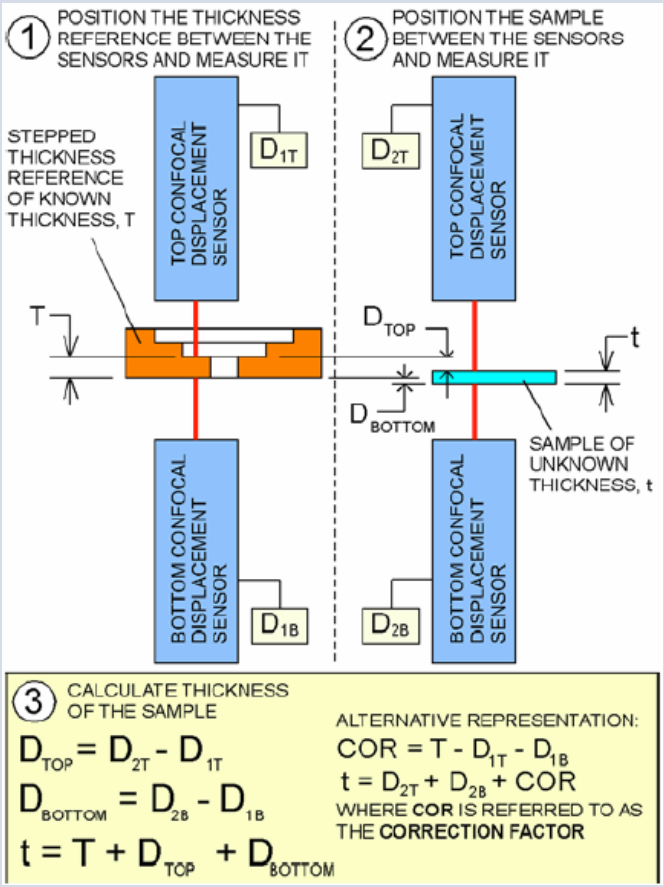
- White light interferometer or laser probe
- Able to measure thickness with an uncertainty of 100 nm



Design Logic For Absolute Thickness Measuring Machine (ATMM)

- Measure both sides of a sample simultaneous with laser probes
- Be able to take in situ calibration measures for different step heights or thickness samples
- Scan to be able to get profile data

Measureing Thickness Using ATMM



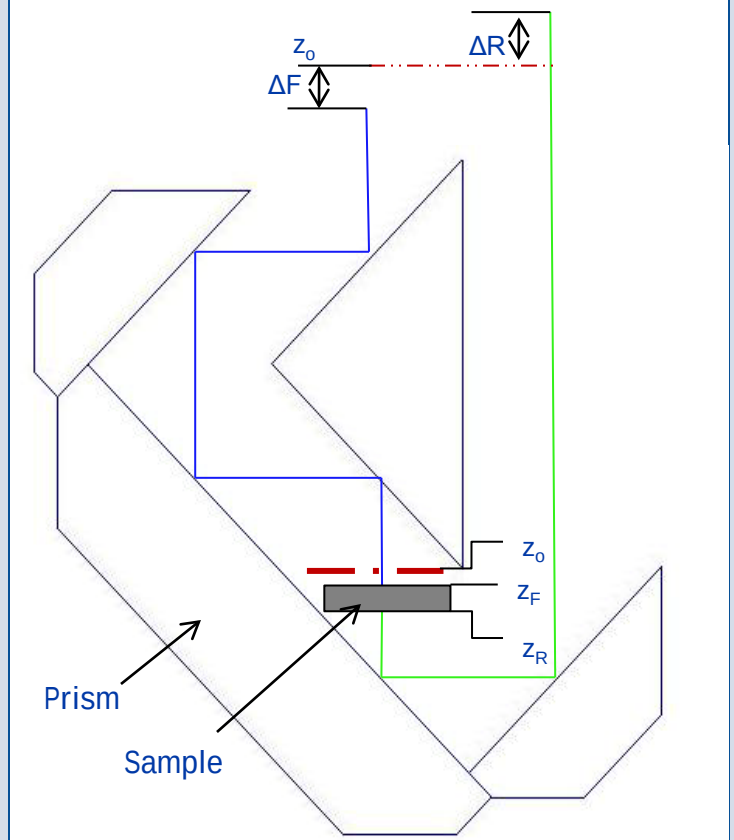
What did we learn from ATMM

- Confocal laser probes preferred to triangulation laser probes
- Confocal laser probes have trouble measuring transparent samples
- Confocal laser probes sensitive to ~3°
- Controls need to be commercially supported
- Compact foot print desired

Design Logic For Double Sided Interferometer Prism (DSI Prism)

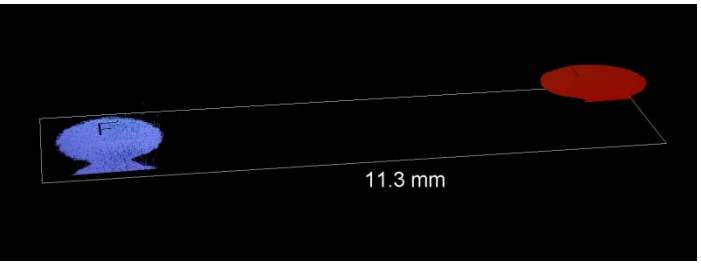
- Measure both sides of a sample in one setup
- Use both white light interferometry (WLI) and laser probe
- Use commercially support equipment
- Be able to get thickness data and form data in one measurement with WLI
- Compact design

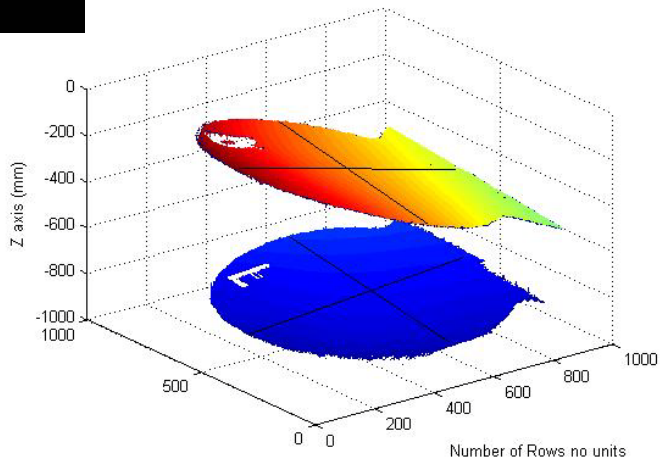
Measuring Thickness Using DSI Prism

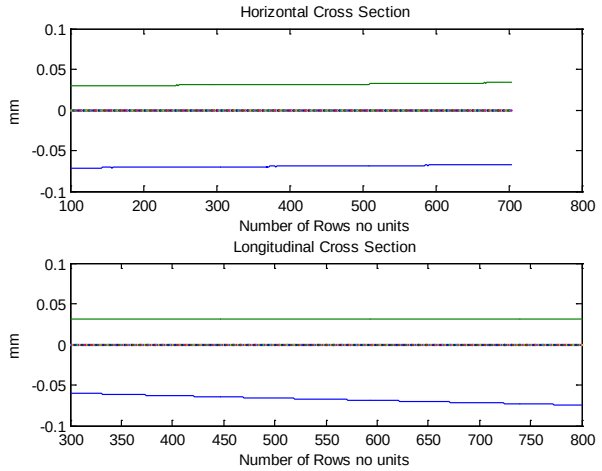


What did we learn from DSI Prism design

- Prism very difficult to manufacture
- Complex error map needed to compensate for Prism miss alignment





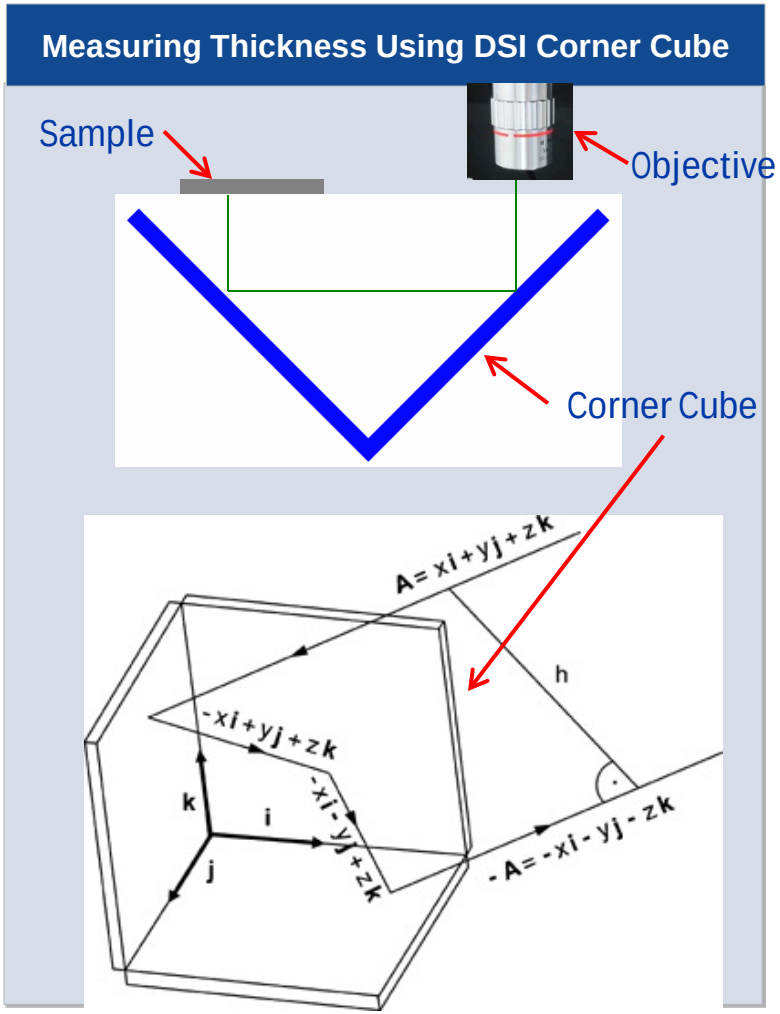


What did we learn from DSI Prism design (cont.)

- White light interferometer z stage does not repeat to starting position to better than 1µm
- Four mirrors depreciate the intensity of the light by 45%, making transparent surfaces not measureable
- Post processing of data is needed to get thickness measurements

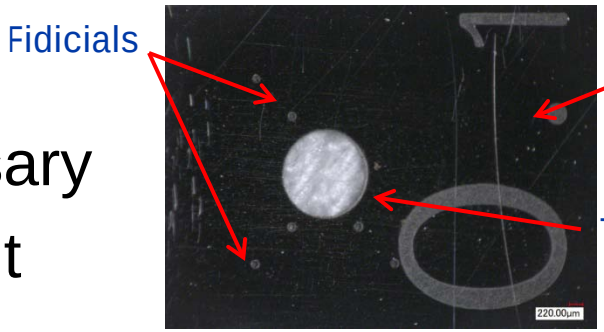
Design Logic For Double Sided Interferometer Corner Cube (DSI Corner Cube)

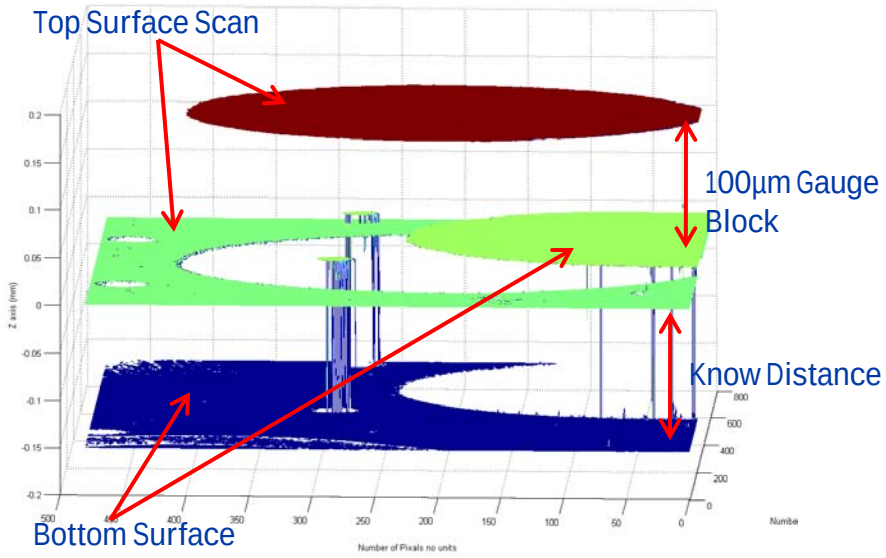
- Measure both sides of a sample in one setup
- Use both white light interferometry (WLI) and laser probe
- Use commercially support equipment
- Be able to get thickness data and form data in one measurement with WLI
- Compact design

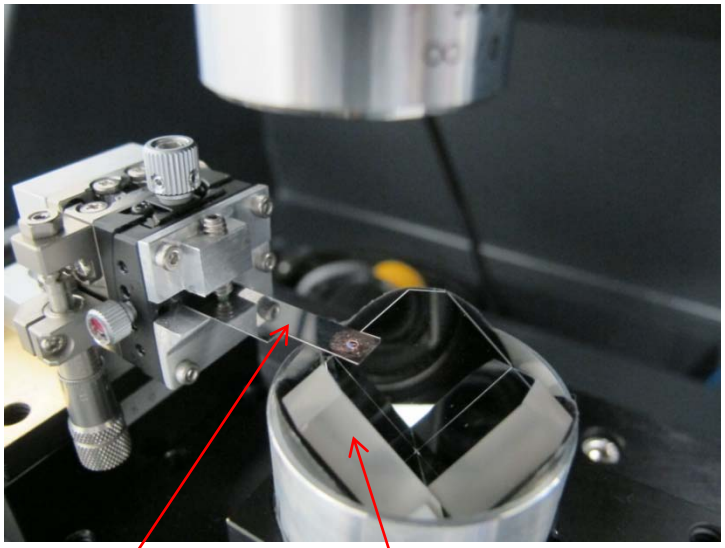


What did we learn from DSI Corner Cube

- Simpler is better
- Post process of data is necessary
- The reference is very important

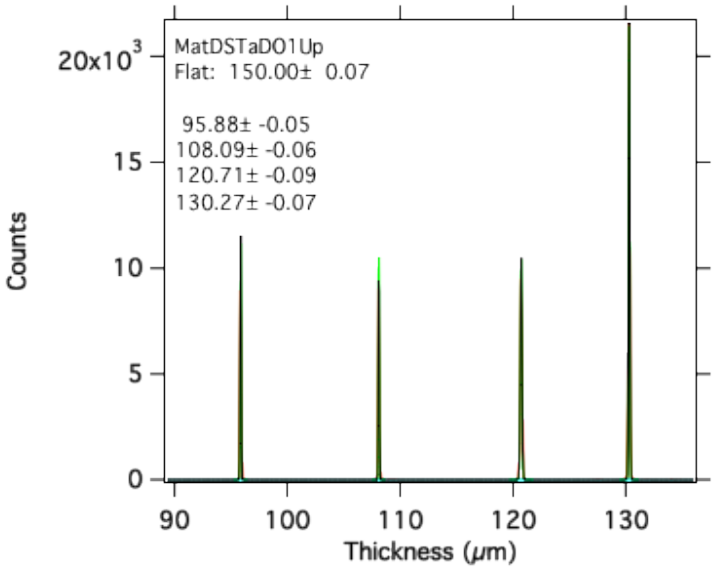




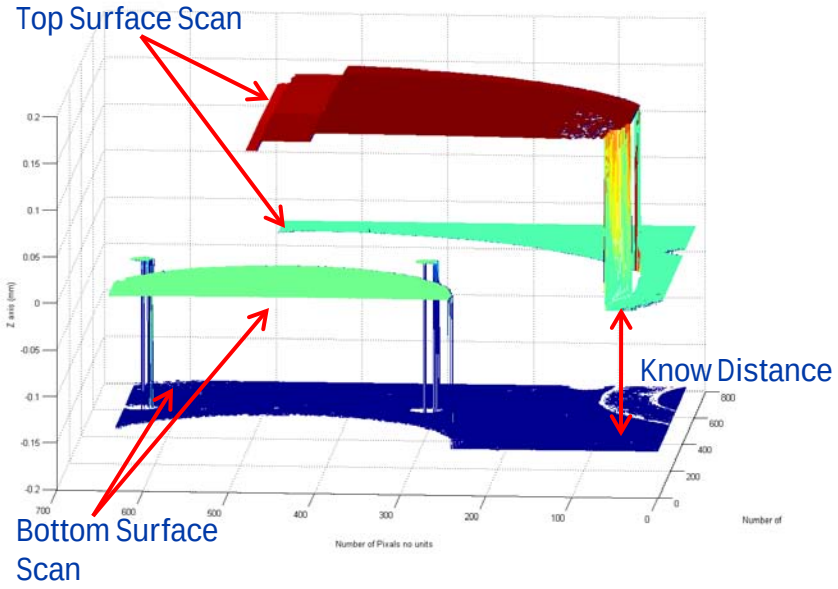


Data For MatDS Ta EOSDrv NIF Experiment

Histogram of The Subtracted Data



3D Plot of Data Set



Future Work

- Develop kinematic hardware for holding references and work pieces
- Develop algorithms to automate the process and analyze the data
- Design, develop, and test a system in a glove box

Acknowledgements

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Thank You